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GLOBAL OCEAN OBSERVING SYSTEM (GOOS)

Report of the Secretary-General of the Conference

I. INTRODUCTION

1. At its first session, the Preparatory Committee in its decision 1/20, paragraph 3, invited the United Nations Environment Programme, the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization, and the World Meteorological Organization to study ways and means of strengthening observation systems to protect oceans, inter alia, through the establishment of a global ocean observation system.

2. In response, IOC has prepared the following report in co-operation with UNEP and WMO.

II. PRESENTATION

A. Purpose

3. A Global Ocean Observing System is necessary for the adequate analysis and prediction of the state of the marine and coastal environment and its interaction with atmospheric and terrestrial processes essential to life on this planet. Sustainable development of any kind is unachievable without

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basic information concerning resources and environmental conditions and reliable forecasting capabilities. Information on emerging environmental problems and capabilities to effectively address potential environmental impacts are virtually non-existent at the present time in most parts of the world. A Global Ocean Observing System will include the collection, analysis and distribution of data and related products from the oceans, enclosed and semi-enclosed seas and coastal areas according to a globally-coordinated scientifically-based strategy. Because of the special vulnerability of coastal waters to adverse effects of human activities and because of the large socio-economic benefits derived from coastal regions, observations will be concentrated in these areas.

B. The Role of the Ocean in Global Change and its Impact on Economic Development Potential

4. Today's environmental problems stem from insufficient attention to the need for environmental protection in the course of economic development. Often such inattention has been and is presently caused by a fundamental lack of knowledge of the effects of human activities on our earth's natural resources. We do not yet know how to accurately predict the future state of the environment, to effectively analyse the increasing amounts of data on the global ecosystem, and to wisely determine the appropriate balance between economic development and environmental stability.

5. The oceans, covering 71 per cent of the earth's surface, have played and will continue to play a decisive role in shaping the life on this planet. The global energy budget and the biogeochemical processes on which all life depends are critically influenced by the oceans.

6. The oceans and coastal terrestrial areas interact intimately. The ecological systems of the coastal areas, as well as the socio-economic development of these areas, are heavily influenced by the conditions created by the proximity of the oceans. Nowhere is this mutual interdependence and influence so evident as in the coastal and near-shore zones of enclosed and semi-enclosed seas, and on islands. Population density and population growth are highest near the coastal zone. By the year 2000 it is estimated that 75 per cent of the global population will live within 60 kilometres of the coast (United Nations, 1985). The nature and causes of present problems of coastal and ocean management are also discussed extensively in UNCED Document 5, Climate Change Impacts.

7. Due to the natural resources found in coastal and near-shore areas, these regions have been among the most intensively used parts of the planet since ancient times. Our use of the coastal zone is multi-faceted: fisheries (80 per cent of the world's fish supply comes from within 9 kilometres of the coast), settlement, large-scale industrial development, tourism and recreation, transportation, water discharge and waste disposal. There are demonstrated relationships between physical oceanic processes, biological activity, and fish stock recruitment; between nutrient enrichment and excessive algal blooms; between the quality of mariculture products and water quality conditions, to name a few. Changes in sea level and shoreline exposure to waves and storm surge can have a major consequence on the value of coastal lands.

8. Coastal zone management, with development policies integrated with policies for management of the environment and its resources, is today accepted as an effective framework for addressing the environmental problems of coastal areas. However, knowledge and understanding of the severity of the problems is a prerequisite. The concept of integrated coastal zone management and associated issues are described in detail in UNCED companion Document 2, Development of Coastal Areas and Enclosed Seas. It urges that attention be given to increasing our understanding of ocean processes for effective coastal zone management and notes that inadequate information on which to base decisions has been one reason for limited application of this concept to date. Hence, implementation of this concept will benefit directly from a Global Ocean Observing System.

9. Environmental degradation of coastal areas and increases in pollution of near-shore waters are occurring at an alarming rate. Enclosed and semi-enclosed seas are especially vulnerable. Coastal waste management policies must be based on a knowledge of the ecological effects of wastes in an effort to ensure that unacceptable effects do not occur. There are, however, some encouraging examples of areas where management measures have led to improvements such as the Thames Estuary (increased dissolved oxygen), the coast of California (particularly reduction in levels of DDT) and Japanese waters (particularly reductions in the level of toxic metals). These improvements became possible when sufficient observations were available to define the problems, to delineate the causes and to demand remedial actions.

10. Potential effects of climate change will aggravate present problems and add another dimension to their complexity. Some impacts of global warming in coastal areas can be anticipated now, for example, sea level rise and especially extreme events such as storm surges. Low-lying countries and small islands are particularly vulnerable to inundation. World leaders have agreed that the severity of the problem requires attention now. Response options are being considered. Such decisions should be based on the best possible scientific understanding and predictive information concerning the rate and magnitude of change.

11. The oceans play a major role in the Earth climate system. They moderate seasonal variations; they store and transport large amounts of heat, resulting in interannual climate variations; and they are a major factor in the biogeochemical cycles of greenhouse gases. The ocean drives the global cycle of evaporation and rainfall. Any possibility of predicting climatic changes beyond a few weeks demands that ocean conditions also be taken into account. While considerable progress is being made in understanding the role of the ocean in climate variations, more attention must be given to observations of properties and processes in the upper ocean, in the mid-depth regions and at great oceanic depths to improve climate predictability. Document 5, Climate Change Impacts, provides further details on the role of the oceans.

12. There are substantial socio-economic benefits to be derived from improved predictability of ocean conditions and processes. Forecasts of winds, temperatures, waves and currents for periods of days to weeks into the future will increase the efficiency and safety, and reduce the costs, of maritime operations such as fishing, ship routing, offshore oil and gas operations,

hazardous spill response and search and rescue operations. Interannual climate forecasts of seasons to several years will benefit agricultural planning, fisheries management and energy management. Reliable assessments of climate change over several decades will be useful in coastal facility design and construction and in projection of long-term energy requirements.

13. Observing, understanding and predicting environmental change are required to establish the socio-economic impacts for management and development purposes and the long-term policies to mitigate the undesirable effects of such changes. The lack of systematic long-term observational data on a global and regional scale substantially limits predictive capabilities today. Nations are being called upon to cooperate in a comprehensive effort, according to a globally coordinated strategy, to determine ocean processes and changes in the state of the marine and coastal environment and interactions with atmospheric and terrestrial processes. Only a globally applied strategy will contribute to a long-term solution.

III. SITUATION ANALYSIS

A. Impacts of Environmental Change on Economic Development: The Economic Value of Adequate Assessments and Predictions

14. Environmental change has fundamental implications on economic development. The types of oceanic changes that serve as environmental indicators and may produce adverse impacts include:

- Sea level change
- Changes in upper ocean temperatures affecting fish stocks
- Changes in locations of upwelling zones affecting fish stocks
- Changes in storm paths and storminess
- Changes in sea ice distribution
- Possible changes in major ocean currents such as the Gulf Stream and Kuroshio Current

15. Other changes that can serve as early warning systems include incidents of coral bleaching and changes in plankton distributions or plankton structures.

16. The most recent climate change forecast, adopted by the Second World Climate Conference, predicts a sea level rise of 65 centimetres plus or minus 35 centimetres by the end of the next century. A one meter rise in sea level could affect all land up to five metres in elevation. A total of five million square kilometres is at risk, 3 per cent of the world's total land but one-third of global cropland and home to one billion people. Although no comprehensive studies have been undertaken, site-specific studies suggest that incorporating projections of sea level rise and other environmental changes into land-use planning can save significant amounts of money. Land-use policies, building codes, etc., can be modified if adequate long-term predictive information is available. Sea level rise will also impact on fresh water supplies for human consumption and agricultural irrigation. Oceanographic observations to improve forecasts for pollution purposes, commercial fisheries development, and weather changes also result in considerable economic benefits.

17. The IOC, WMO and UNEP have gained considerable experience in operational global environmental monitoring systems such as the World Weather Watch (WMO), the Integrated Global Ocean Services System (IOC-WMO), the Global Sea Level Observing System (IOC) and the Global Investigation of Pollution in the Marine Environment (IOC-UNEP). The economic benefits derived from the World Weather Watch are estimated to be 100 times greater than the cost of the system. Meteorological services, which depend upon data describing ocean conditions, are an essential contribution to the economic well-being of almost every country. Timely warnings of severe or hazardous weather or flooding help to protect life and property and facilitate commerce, agriculture, energy, transportation and water use activities. Examples of economic benefits include timely warnings of typhoons in Eastern Asia which allow thousands of fishing vessels to take shelter and rice to be harvested before damaging weather commences. In China recent timely forecasting of typhoon rains allowed 38 dams and reservoirs to be opened before flooding occurred, and the resulting lack of damage to the dams saved an estimate $US 286 million. Although forecasts are at times accurate, in the case of the devastating May 1991 Bangladesh cyclone for example, severe weather warnings are frequently not given due to the lack of data and the need for predictive modeling capabilities. It is essential that such service be available world-wide and, most importantly, be reliable.

18. Significant changes in sea surface temperature identified in the central and eastern tropical Pacific together with systematic variations in atmospheric pressure in the Southern Hemisphere have been termed "El Nino" Southern Oscillation (ENSO) events. In 1982-83 effects of the strongest ENSO event of this century were felt world-wide and were not limited to weather. The marine ecosystem in the central and eastern equatorial Pacific experienced the most direct consequences, such as the migration southward of the coastal fisheries to avoid the warm water. One of the most dramatic earlier consequences was the catastrophic collapse of anchovy stocks off the coast of Peru due to the El Nino of 1972-73. The resulting overfishing caused repercussions throughout the world commodities markets. Important indirect or secondary effects have been noted in other locations world-wide. For instance, during the 1982-83 El Nino, there were huge drought-related fires in Borneo and Australia, drought-related eradication of sea-bird populations on islands in the Pacific, drought-related famines in India and east Africa, and flooding on the east coast of equatorial South America, in the Rocky Mountain region of the United States and in Brazil south of the equator. With adequate data, predictions can be made which would serve as an early warning system to minimize these adverse effects.

19. The impacts of marine pollution on economic development are well known. The costs of adequate waste disposal are substantial, but the costs are far greater of polluted waters affecting the health of coastal populations. A well-designed system for monitoring suspected pollutants is a prerequisite.

B. Recommendations of the Intergovernmental Panel on Climate Change

20. The Intergovernmental Panel on Climate Change (IPCC) was formed by the United Nations Environment Programme and the World Meteorological Organization in 1988 to provide a basis for the development of a realistic and effective

international strategy for addressing climate change. Reports of the three IPCC Working Groups have been completed; independent conclusions of each group call for an ocean monitoring program in order to narrow the uncertainties, to address the impacts, and to identify appropriate response strategies.

21. The IPCC has recognized the need for systematic ongoing observations of the global ocean and has recommended the development and implementation of multi-national systems to detect and monitor ocean and coastal zone changes and environmental and socioeconomic impacts of those changes. The IPCC June 1990 report called "Scientific Assessment of Climate Change" states that "systematic ongoing observations of the global ocean are needed" and "a comprehensive ocean and ice observing system requires:

(a) satellite observations of the ocean surface temperature, wind and topography, sea-ice concentration and chlorophyll content (ocean colour), and of the topography of the Antarctic and Greenland ice sheets, by an international array of space platforms in suitable orbits around the earth;

(b) an international operational upper-ocean monitoring programme, to determine the time and space dependent distribution of heat and fresh water in upper ocean layers, seasonal variations and long-term trends; and

(c) an international program of systematic sea-level and deep-ocean measurements, at suitable time and space intervals, to determine the state of the ocean circulation, ocean volume, and transport of heat."

22. The Fifth Plenary Session of the IPCC (Geneva, 13-15 March 1991) noted the widespread and urgent requirement for predictions of the regional distributions of climate change but determined that major improvements in the level of confidence of regional predictions would take 5-10 years. Work must begin now to develop an integrated ocean observing system, it noted, to support regional models.

C. Recommendations of the Second World Climate Conference

23. The Scientific and Technical Sessions of the Second World Climate Conference in October 1990 identified an urgent need to create a Global Climate Observing System to be built on:

- An improved World Weather Watch Programme and further development of the IOC-WMO Integrated Global Ocean Services System
- A Global Ocean Observing System of physical, chemical and biological measurements
- A monitoring programme of other key components of the climate system.

Both satellite and surface ocean observations will be included.

D. United Nations, IOC and WMO Resolutions

24. In response to the United Nations General Assembly Resolution on the Protection of Global Climate for Present and Future Generations of Mankind and recommendations made by Working Groups of the Intergovernmental Panel on Climate Change, the Intergovernmental Oceanographic Commission (IOC) has initiated development of a comprehensive Global Ocean Observing System (IOC Resolutions XV-4 and XXIII-5). The World Meteorological Organization (WMO) passed a similar resolution in 1989 to cooperate with the IOC on this initiative. The 16th Session of the IOC Assembly in 1991 decided to establish a GOOS Support Office within the IOC Secretariat and invited WMO, UNEP, the International Council of Scientific Unions, and the Committee on Earth Observations Satellites to cooperate with IOC in the planning and development of the GOOS. It also passed a resolution (XVI-16) to submit a Declaration to UNCED, described in Annex 1, in order to foster support and participation in GOOS among all United Nations Member Nations. Subsequently, the World Meteorological Congress in 1991 adopted a resolution supporting the IOC initiative and agreeing to cooperate in the planning and development of GOOS.

25. The IOC Sixteenth Assembly also endorsed the establishment of a GOOS Planning Staff within its Secretariat to develop and co-ordinate plans for GOOS and serve as a focal point. Additionally, it endorsed the creation of a Steering Committee and a Planning Office for a Global Climate Observing System and pledged to include appropriate oceanographic expertise for that effort.

E. Definition of GOOS

26. GOOS is being developed as a comprehensive, integrated system for collecting, analysing and distributing physical, chemical and biological data from the world ocean, including the coastal zone and enclosed and semi-enclosed seas. It will facilitate the protection of the ocean from degradation and alteration of marine ecosystems through increasing our understanding, improve our predictive capabilities and provide predictions of the physical state and health of the ocean and its role in environmental change and economic development. It is to serve as an early warning system. It will provide consistent, long-term data sets through a sustained permanent effort and help predict climate variability and change. GOOS should ultimately be able to supply the data required to support the evaluation of natural and anthropogenic climate changes and the long-range forecasting of weather and climate, as well as regional predictions of ocean conditions for fisheries, coastal zone management, and pollution assessment.

27. GOOS will be developed on a sound scientific basis, taking full advantage of the findings of global research programs. GOOS will be built as far as possible on existing national and international ongoing and planned programmes and capabilities and must be continually updated and improved in response to new results of these national and international research programmes and the development of new technology. The focus is to be on improving coordination and accelerating expansion of existing international ocean observing and data management systems (descriptions of which are given in Annex 2). Close interaction with the scientific community is a prerequisite for the design,

planning and development of a scientifically sound and cost-effective global system. Descriptions of key global research programmes are given in paragraph 2.8.2 below.

28. GOOS is to be analogous in some respects to the World Weather Watch of WMO and will include, inter alia, a large range of national ocean observation systems, from which a subset of data will be identified as required for global exchange and management. GOOS will build on the Integrated Global Ocean Services System, a joint IOC-WMO activity for the collection and exchange of surface and sub-surface temperature, salinity and current data.

Categories of data required for GOOS include:

- Upper ocean measurements to determine the time and space dependent distribution of heat and fresh water, sea level, carbon dioxide content, air-sea fluxes and plankton distribution

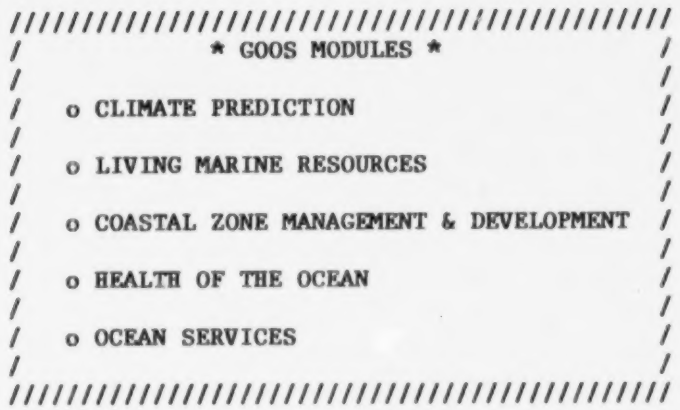
- Systematic deep ocean measurements at suitable time and space intervals to determine the state of ocean circulation, physical and chemical properties, transient tracers and carbon dioxide

- Satellite observations of ocean surface temperature, wind, sea surface elevation, precipitation, sea ice concentration and chlorophyll content (ocean colour) by an international array of space platforms in suitable orbits around the earth

29. Real-time acquisition, reporting and dissemination globally of data from throughout the world ocean, including coastal zones, enclosed and semi-enclosed se s, will be necessary. Specific requirements for space and time resolution and accuracy of measurements will be derived from present global research programmes.

30. Satellite measurements will be extremely important. Fortunately the opportunity for increased satellite earth observation data exploitation is tremendous. Figure 1 depicts a map of a hypothetical future GOOS network. By the year 2001 the volume of satellite data available will increase by two orders of magnitude. Recent advances in satellite data processing capabilities also allow expanded utilization of satellite data.

31. Different elements of GOOS required for climate prediction, coastal zone protection, observation and assessment of living resources, observation and assessment of the health of the ocean and improved ocean services for various national practical applications will be encompassed in subsystems or "modules". Each module will address a set of specific objectives or requirements and will be incorporated into the comprehensive system on the basis of our improved knowledge of ocean processes and the interaction between the oceans and atmosphere and coastal terrestrial areas and other characteristics of the marine environment. Local and regional coastal studies need global input. It is extremely important that the modules be developed in close harmony, both nationally and internationally. Data acquired for one module can also be used concurrently for another so there will be no duplication of effort.


* GOOS MODULES *
o CLIMATE PREDICTION
o LIVING MARINE RESOURCES
o COASTAL ZONE MANAGEMENT & DEVELOPMENT
o HEALTH OF THE OCEAN
o OCEAN SERVICES

a. **The Climate Prediction Module**

32. One of the initial priorities is the climate module. This module of the GOOS will provide the ocean data needs of the Global Climate Observing System. Initial results from the Tropical Oceans Global Atmosphere Research Programme, conducted between 1985-1995, indicate that an operational observing system for selected tropical regions can be implemented by the year 2000. It is critical that research programmes proceed as planned in order to properly establish this module. These programmes include the Tropical Oceans-Global Atmosphere Programme, the World Ocean Circulation Experiment, and the Joint Global Ocean Flux Study.

33. Operation of this module will result in reducing the uncertainty that now exists with regard to the role of the ocean in the timing and patterns of climate variability - seasonal, interannual and decadal. It will provide the input and validation data for coupled air-ocean models. Sampling strategies will have to be defined on the basis of the results of large-scale ocean climate research programmes. One illustration of the challenges faced by the climate module of the GOOS is that optimally measurements of the ocean-atmosphere heat flux are needed to within ± one megawatt per square kilometre. This is the approximate magnitude of the anthropogenic greenhouse enhancement. This signal must be determined from a highly variable background heat flux which is about 100 times larger. Observations will be required to determine the deep ocean circulation in order to understand inter-basin fluxes as well as the seasonal boundary layer. Dynamic changes inside the ocean - at all depths - must be known in order to predict future changes in surface temperatures which provide the boundary conditions for the atmosphere.

34. A plateau in coupled ocean-atmospheric model development will soon be reached without more complete ocean data sets. The design of GOOS includes the concept of interdependence between observing system and model. One or more global ocean data analysis centers may be required. In such an analysis center ocean data could be used for both model and observations system development. This mutual feedback concept is considered essential.

35. Models of coastal ocean processes also need to be greatly improved in order to adequately forecast local and regional climate variability. Systematic data collection needs to be undertaken to improve forecast capabilities of ocean models at basin or smaller scales. The potential increase in data will demand increases in computing capability and further attention to quality control and data exchange protocols.

36. The climate prediction module of GOOS along with the other elements of the Global Climate Observing System will provide the basis to forecast ENSO conditions and possibly the seasonal monsoons.

b. The Living Marine Resources Module

37. Despite research over the past several decades, we have little knowledge of the effects of ocean behavior on living marine resources. The ability to ensure sustainable harvesting of fisheries stocks depends on adequate knowledge and predictive capabilities. Companion Document 4, Living Marine Resources, emphasizes the importance of interdisciplinary work to reduce the present uncertainty in the field of marine resources management. This module of GOOS will include pelagic and benthic sampling while concentrating on observations of ocean features such as coastal upwellings and circulation, for example, that are known to substantially affect production. This module will also provide the oceanographic data necessary for ecosystem models of fish stocks for local and regional predictive needs. Data are needed to describe the structure and functioning of marine ecosystems. To understand biological processes, it is essential to know many oceanic and atmospheric parameters that form the dynamic matrix in which these processes take place. Physical processes in the upper 100-200 metres of the ocean dominate many problems in biological oceanography.

38. Specific requirements, sampling strategies and techniques for this module will be determined in cooperation with the Food and Agriculture Organization (FAO) within the joint IOC-FAO Programme on Ocean Science and Living Resources.

c. The Coastal Zone Management and Development Module

39. The GOOS coastal components have a high priority to many coastal states because of the intimate effects of coastal changes on economic development. Monitoring and documenting changes in coastal and near-shore areas requires a global and an interdisciplinary approach that integrates physical, chemical, biological and geological observations with socio-economic uses of the coastal zone.

40. UNEP, IOC, and WMO have developed a proposal for long-term monitoring in the coastal zone as one module of the Global Ocean Observing System. The proposed system ensures that measurement frequency, spatial resolution, and parameter selection will be adequate in the area most likely to be affected first by anthropogenic influences, and it will also complete the suite of observations necessary for global numerical models. In coordination with the UNEP Regional Seas Programme and IOC regional bodies, the system will draw on existing and planned data collection and exchange systems, adding complementary measurements not now taken such as biological and chemical

observations. Emphasis will be placed on strengthening national infrastructures to utilize data at the local and regional level, to assess change and its impacts and to facilitate establishment of policies to mitigate undesirable effects. A series of pilot projects has been suggested to measure key variables over a three-year test period. These variables include:

- o Sea level changes and coastal flooding
- o Coastal circulation
- o Assessment of organic carbon accumulation in coastal sediments
- o Changes in plankton community structure
- o Benthic communities; coral reef ecosystems
- o Terrestrial vegetation; mangrove communities

41. Consideration is being given to the support of the ongoing study of "large marine ecosystems" for the organization of some coastal aspects of GOOS. A total of 48 large marine ecosystems have been characterized to date. These regions, measuring 200,000 square metres or greater, have distinct hydrographic regimes, submarine topographies, and biological productivity. They could be a particularly useful definition for monitoring holistically the health of the ocean on a regional basis. IOC has established seven regional subsidiary intergovernmental bodies; UNEP manages 12 Regional Seas Programmes; and WMO has 6 Regional Associations. These elements will be used in the management aspects of GOOS.

d. The Health of the Ocean Module

42. Companion Document 3, Marine Pollution Control Strategies, points out that most human activities affect the ocean. Global strategies are essential if all elements of the marine environment are to be protected. The extent of existing pollution problems is not well-known globally, however, because of the lack of efficient, comprehensive monitoring and assessment activities in most regions of the world. While the Group of Experts on Scientific Aspects of Marine Pollution (GESAMP) concluded in 1989 that open ocean areas are relatively free of the effects of pollution from land- based sources, coastal areas are, however, suffering. The lack of knowledge of the status of the marine environment frequently results in extreme impacts, as seen, for example, in the recent outbreak of the cholera epidemic in Peru which to date has killed 1200 persons. Because of the transboundary nature of marine pollution, dependence on national programs alone is inadequate. Additionally many countries lack the basic infrastructure. Regional assessment programs have been shown to be successful as in the case of the Mediterranean region where contracting parties agreed in 1976 to conduct a permanent monitoring system under the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution.

43. This module of GOOS aims to establish a framework for measuring trends in levels of pollutants, including development of baseline data sets and quality control standards, provision of technical assistance and development of central data bases. Data collection and analysis is to be based on proven scientific methodologies. The monitoring and assessment capabilities thus developed will serve the needs for effective national and regional

implementation of the United Nations Convention on the Law of the Sea and provisions of the Montreal Guidelines for the Protection of the Marine Environment against Pollution from Land-Based Sources.

44. Strategies and techniques for assessing pollution levels is being determined by a joint IOC- UNEP programme called Global Investigation of Pollution in the Marine Environment (GIPME) and related IOC and UNEP activities such as the UNEP Regional Seas Programme and Marine Pollution Monitoring (MARPOLMON). Studies of selected pollutants must be based on the use of unified methods and technologies so that results are intercomparable. This module will include regional components with specific observational networks, geared to problems of each region.

45. At present, pollution monitoring is accomplished mainly through routine sampling and analysis based on periodic ship cruises. However, developments in instrumentation and methodologies envisaged under GOOS will afford greatly improved large-scale and repetitive real- time data, especially for those parameters that vary rapidly in time and space. By affording real-time data to the GIPME programme, GOOS will considerably enhance response effectiveness in the case of pollution incidents, such as accidental oil or chemical spills.

46. This module of the GOOS will provide basic information on the transport and fate of pollutants in the ocean with primary emphasis on nearshore regions. It will enable more effective and efficient responses to accidental releases of hazardous materials to the ocean. The release of oil during the Gulf War, the Exxon Valdez oil spill off Alaska, and the release of radionuclides into the Black Sea from the Chernobyl accident provide examples in which knowledge of coastal processes is needed to minimize the impacts on marine ecosystems of pollutant releases.

e. The Ocean Services Module

47. Marine meteorological and surface oceanographic data from most ocean areas are extremely important for basic short to medium range weather predictions along with effective response procedures. Improved warnings of severe weather and extreme weather events would save thousands of lives per year. On a time scale of more than a few days, the prediction of weather is not possible without some knowledge of the state of the upper ocean. Marine meteorological and surface oceanographic data contribute to the safety of life at sea, to the economical operation of shipping, to tourism and recreational opportunities, to seabed exploration and coastal engineering. This module of GOOS will focus on increasing the amount of data for immediate real-time forecast needs. Requirements for marine meteorological and surface oceanographic data in support of short-range weather prediction and related services have been defined by the World Meteorological Organization's World Weather Watch.

f. Products

48. With data obtained through GOOS, products can be prepared for economic and commercial applications by participating countries. Forecasts and analyses of meteorological, hydrological and maritime conditions can be made

based on products describing ocean features such as sea surface temperature, ocean current and heat flux. Products must be quickly and easily available, up-to-date, have sufficient spatial detail to show major ocean fluctuations. Some products will be "blended", using a combination of conventional (in situ) data and satellite data.

49. An example of such products is a potential set of global ocean climate diagnostic charts based on observations that have been assimilated into a numerical model. This information is potentially extremely useful for agricultural planning, for instance. Another example is analyses of local and global sea level trends, seasonal variations and identification of anomalously high or low levels occurring in particular areas. GOOS products will also support assessments in the case of the accidental release of hazardous materials into the ocean. Such events require a rapid exchange of marine environmental information and the provision of specialized products indicating the transport, dispersion and deposition of hazardous materials and effects on marine ecosystems and coastal zones.

50. Fishermen can use GOOS products to better understand past, present and predicted ocean conditions for locating fish populations. Short-term forecasts can affect decisions on the day-to-day movement of individual vessels and best operating depths. Effective management of fishery resources requires information on past, present and future status of stocks which are directly related to oceanographic conditions.

51. Marine meteorological and oceanographic products benefit the economy, efficiency and safety of shipping operations. From information provided on winds, ocean currents, surface and sub-surface temperatures and salinity, the growth, decay and movement of sea ice and icebergs can be forecast.

g. Funding Requirements

52. The total annual costs for a fully implemented Global Ocean Observing System have not been established. Most projections suggest that it will take about two decades of development and evolution to obtain the system outlined in the preceding sections. Some resources for the GOOS are already anticipated by ongoing and planned progammes, but there will be additional incremental costs to achieve the observational capability required in the marine environment.

53. Woods (1990) provided one estimate and rationale for the level of resources required to support the ocean services and climate modules of GOOS. He assumed that the global investment in GOOS should be about the same as what the nations of the world presently devote to weather prediction observations through the World Weather Watch, which is about $US 2 billion per year. He also estimated that about one-half of the expenditures would be needed for observations from earth orbiting satellites. The other half would be required for measurements within the ocean and for data processing, management and distribution. The table below gives Woods estimates.

	Unit Life years	Capital $m/y	Running $m/y	Total $m/y
Space Observations				
4 small satellites	5	480	160	640
4 large satellites	5	480	160	640
Ocean Observations				
100 autosubs	3	80	180	260
Acoustic remote sensing	3	90	90	180
Drifting instruments	2	66	14	80
Fixed instrument	2	26	26	52
Data Management				
Communications	5	100	100	200
Computing	5	100	100	200
Archiving		100	100	200
TOTAL		1522	930	2452

54. Development of autonomous instrument technology to replace measurements taken by ships is seen as a method of reducing costs and enabling a high sampling density. Data management costs include super computers to integrate the GOOS data with fine resolution models.

55. With such a system in place, annually updated descriptions of the climate of the open ocean might be produced in order to provide boundary conditions for predictions of coastal water quality and fisheries. Thus, this sub-system of GOOS, while designed for climate, has immediate and local economic applications.

56. It is estimated that present oceanic observational systems (described in Annex 2) cost $US 50 million per year. Research programmes are the major source of this funding. It is essential that GOOS be established with operational funding, as a long-term service rather than depend upon data collection efforts of research activities that have definite durations.

57. The costs to support a Global Ocean Observing System will be shared by those nations that benefit from it through participation in national, regional and global programmes.

h. National Capabilities

58. National institutions responsible for marine environmental protection need to be established or strengthened in many countries. Their influence on national development planning needs to be enhanced. Without creating strong national infrastructures, equipped with interdisciplinary scientific expertise, and without access to decision-making authorities, no effective protection and integrated management of the coastal and marine environment can take place.

59. The global and long-term nature of GOOS requires the active involvement of many countries through national services and facilities based on the principle that each country participates, according to its means, to meet certain responsibilities in the agreed global scheme, so that all countries may benefit. Substantial training, education and mutual assistance efforts must be undertaken to enable developing countries to actively participate in GOOS and to interpret and apply effectively the resulting data and information for national uses. The establishment of regional consortia to address some aspects of GOOS may be a cost-effective way to implement an observing system.

60. Exchanges of technology and products must be encouraged, and the concept of partnerships between developed and developing countries must be fostered. Companion Document 1, Capacity Building, presents a detailed discussion of the importance of technical assistance as a fundamental ingredient in a long-term strategy for strengthening national capabilities. It points out that few countries now have adequate information on the state of their coastal and marine resources but such information is essential for sustainable economic development of these resources.

61. The protection and development of seas and coastal areas require a variety of expertise and a full recognition of the cross-sectoral nature of environmental protection. While narrow, sectoral expertise exists in most countries, great efforts should be devoted to the training of experts in interdisciplinary skills.

62. Because of the need for data from all ocean areas and the value of such data to all nations, GOOS will depend critically on the free and open exchange of data. High priority is placed on the establishment, maintenance, validation, description, accessibility and distribution of high quality, long-term data sets. Data should be available for no more than the cost of reproduction and distribution.

63. A great deal of data now exists which is not readily available or centrally archived, pointing to the need for increased attention to national, regional and international inter-agency cooperation in data management. Data sets need to be inventoried, data bases need to be standardized and information about data needs to be readily accessible. Examples of coastal zone data sets and analyses which exist but are not readily available are described in UNCED Document 5, entitled Climate Change Impacts.

i. Status of Implementation of GOOS

64. The following section describes ongoing ocean observation and data management efforts. Additional information on these activities is given in Annex 2. In order to make data readily available for accurate assessments of the marine environment, these activities will need to work closely together. GOOS is seen as an evolving effort which will coordinate and may ultimately merge a number of these systems to facilitate the rapid exchange of information and preparation of products and environmental indicators.

a. Status of Implementation of Existing Systems

65. Regular oceanographic and marine meteorological observations have been made for many years, mainly in limited coastal and near-shore areas. These efforts support fisheries, coastal zone management, and preparation of forecasts of sea-ice and natural hazards, such as storm surge and tsunami events. The first international collaboration to obtain weather observations over the oceans started in the second half of the 19th century. As a result of such collaboration, a Voluntary Observing Ship Scheme was established under the aegis of WMO. At present the 7000 voluntary observing ships, constituting an important element of the Global Observing System of the WMO's World Weather Watch, collect and transmit in real-time surface meteorological and some ocean surface observations (including sea surface temperature, wave heights and sea-ice).

66. In the mid 1960s IOC in co-operation with WMO initiated the Integrated Global Ocean Services System (IGOSS) for the timely acquisition and exchange of oceanographic data, the provision of services and dissemination of data products. IGOSS is an operational system which relies to a large extent on the Global Telecommunications System of the WMO for real-time data exchange. The IGOSS observing system includes the use of national research ships and ships-of- opportunity, equipped with expendable and other measuring devices for subsurface measurements of temperature, salinity/conductivity and currents. At present some 200 ships (both research and merchant) from 23 countries contribute to the collection of IGOSS data. A few ships carry acoustic doppler current profilers which directly measure the vertical profile of ocean currents. The IGOSS Plan and Implementation Programme (1989-1995) calls for equipping 500 ships with automatic data formatting and reporting systems to improve the global coverage and spatial and temporal resolution of these ocean observations.

67. From the mid 1970s moored and drifting buoys and coastal sea-level stations have been deployed by some countries and data have been incorporated into the IGOSS system. In the mid 1980s WMO jointly with IOC established the Drifting Buoy Co-operation Panel (DBCP) in order to encourage and support drifting buoy deployments for meteorological and oceanographic observations. There are presently 600 drifting buoys operated by 11 countries. They utilize the Argos satellite communication and data processing system. Most of the buoys measure air pressure and/or sea-surface temperature. Of those, 35-50 per cent have their data disseminated globally via the Global Telecommunications System.

68. In the mid 1980s the IOC also initiated the development of the Global Sea Level Observing System (GLOSS) in order to provide high-quality standardized sea level data from a global network of sea-level stations. The GLOSS implementation plan calls for the establishment of 300 permanent sea-level stations for determining changes in sea-level due to global warming and patterns of ocean circulation. About 220 of the GLOSS stations are operational or committed, but about 50 of the other 80 stations are located in hazardous areas such as polar regions and isolated islands which will require special efforts and technology to establish and maintain. The submission of sea-level data from GLOSS stations to international sea-level data centres on a timely basis is an important factor in making these data useful.

69. International exchange of oceanographic data is presently carried out through operational channels of communication and the use of satellites, coastal radio stations and the Global Telecommunications System. Since 1960 IOC in co-operation with the International Council of Scientific Union's World Data Center (WDC) system has continued the development of the International Oceanographic Data and Information Exchange (IODE) system for the delayed mode exchange of data between national and international centers. The various oceanographic data sets (physical, biological, chemical and geological) are exchanged freely and archived in 3 WDCs for oceanography. Forty countries have established National Oceanographic Data Centres/Designated National Agencies. A number of international centres have been established to assist the international oceanographic community to collect, process and analyse certain types of data and/or to provide certain services in support of international research and monitoring programmes. They include also Global, Specialized and National centers for IGOSS. The use of standard formats facilitate data exchange. In addition to magnetic tapes, some countries have recently begun to use compact disks to store and exchange data. This technology provides new opportunities for many developing countries to access global and regional data sets and products.

70. Satellite observations, which began just over 30 years ago, have a special importance over the oceans. Currently polar orbiting satellites are operated by France, India, Japan, the United States and the USSR. Geostationary meteorological satellites are operated at different locations over the equator by the European Satellite Consortium countries, India, Japan and the United States. Each of these satellites carries a variety of sensors allowing derivation of sea surface temperature, atmospheric pressure, and cloud temperature. They also provide a substantial capacity for data relay of surface observations. Twenty polar-orbiting satellites or satellite series with the capability to support marine meteorology and physical oceanography are planned for launch during the decade of the 1990s. Satellite series equipped with scatterometers, altimeters, visible and infrared radiation, passive microwave and synthetic aperture radar devices will provide global coverage of critical surface variables, such as sea level, waves, sea-ice, wind stress, sea surface temperature, radiation, precipitation and surface water chlorophyll concentration. It is expected that by the year 2001 the volume of environmental satellite data available will increase by two orders of magnitude.

71. Analysis of existing ocean observing and related data management systems (IGOSS, GLOSS, IODE, WWW [marine meteorological component], etc.) shows that the coverage and total volume, especially with regard to subsurface oceanographic observations, accuracy and data submission, are not sufficient to meet requirements for monitoring and prediction of global climate and environmental change. The present increase of some oceanographic measurements within large-scale research programmes, such as TOGA, WOCE, and JGOFS is limited to the duration of these scientific experiments. An international cooperative effort will be necessary to provide the long-term systematic ocean observations for addressing the issues of regional and global change in the marine environment.

72. Present progress in technology for oceanographic observations as well as for processing the huge volume of data that may be expected from satellites

and other automatic systems is very encouraging. This progress now makes it feasible to develop an internationally co-ordinated long-term measurement and monitoring system built as much as possible on existing or planned national and international systems to support the preparation of accurate assessments and reliable predictions of global changes. Technical assistance will be required to enable developing countries to participate in, utilize and benefit from the Global Ocean Observing System.

A summary of ongoing activities is given in Annex 2.

b. Requirements Identified by Large-scale Research Programmes

73. Large-scale climate research programmes such as the Tropical Oceans-Global Atmosphere Programme and the World Ocean Circulation Experiment have identified the observational requirements for achieving their objectives. Although some requirements may change in the coming decades as our knowledge increases, the experience provided by these research programmes will be used to establish and refine the initial parameters, processes, features, and phenomena to be measured over the long term. Close interaction is taking place with relevant scientific groups in order to insure the sound scientific design for GOOS.

74. Requirements for long-term systematic ocean observations are being addressed by an Ocean Observing System Development Panel sponsored by the World Climate Research Programme's Joint Scientific Committee and the Committee on Climatic Changes and the Ocean (a joint activity of the Scientific Committee on Ocean Research and the IOC). This group will formulate the conceptual design of a long-term, systematic observing system in order to monitor, describe and understand the physical and biogeochemical properties that determine ocean circulation and the seasonal to decadal climate changes in the ocean and to provide the observations needed for climate predictions.

j. Institutional Mechanisms

75. Effective protection of the oceans from degradation due to human activities can be achieved only through a high level of intergovernmental cooperation. It is thus essential to strengthen and expand multilateral programmes and agreements designed to protect the marine and coastal environment according to the specific needs of the countries concerned.

76. Close coordination needs to be developed and maintained between the Global Ocean Observing System development and other climate and environmental monitoring activities of the WMO and UNEP. Such steps are being taken with the joint efforts, described above, to develop a Global Climate Observing System, of which the climate module of GOOS is a part, and a global coastal monitoring system under the auspices of UNEP, IOC, and WMO. GOOS, like the present IGOSS and drifting buoy programmes, is a joint IOC and WMO undertaking. Advice and assistance from still other organizations, such as FAO and IAEA, is being sought.

77. The GOOS system will require that operational oceanographic services be established at the national or regional level and that they work closely with

meteorological services. Participation in GOOS by virtually all maritime countries will be required to achieve the regional and global data needed to sustain the quality of the marine environment and its resources and to allow effective utilization of the oceans in economic development. Substantial efforts must be undertaken to assist developing countries in data analysis and application of data products to their goals. It cannot be overemphasized that a major new commitment will be needed from participating countries.

78. Global and regional agreements, though not universal remedies, provide a legal basis and are among the most forceful international mechanisms and signify a political commitment for joint action. Adoption and adherence to such agreements will contribute substantially to the protection of the marine and coastal environment.

79. At its Sixteenth Assembly the IOC adopted a resolution, shown in Annex 1, calling on the UNCED to adopt a declaration urging countries to support GOOS for their individual and collective benefits. In order for the GOOS system to achieve its objectives, such a cornerstone agreement for commitment, supplemented by regional agreements, will be needed and is foreseen as a catalyst for national action.

IV.ACTIONS REQUIRED

80. A major commitment needs to be made by countries to protect the oceans inter alia through the establishment of a global ocean observing system. The GOOS concept must be endorsed and implementation must proceed, in a step-wise manner, based on scientific results. We must recognize the importance of the continued health of the ocean and marine ecosystems in order to sustain life on earth and permit the sustainable development of our planet.

Specific actions needed include:

(i) Approval of the GOOS Declaration (Annex 1) by UNCED

Although not a formal international agreement, approval of this Declaration would imply:

- o Agreement by nations on the need to undertake systematic, global, operational ocean monitoring in support of several applications
- o Approval of the concept of GOOS as the appropriate mechanism to undertake this monitoring
- o Agreement by nations on the need to commit additional resources over an extended period and on a long-term basis to observe the oceans and coastal seas

(ii) Establishment of an initial plan and implementation programme for GOOS

81. This initial plan will be based on the existing understanding of requirements for systematic ocean monitoring as well as of ocean processes. It will contain priorities for the gradual implementation of GOOS and will

depend on the accelerated development and implementation of existing systems by national facilities. It will also incorporate the ocean observations to be taken by the oceanographic satellites planned for launch during the next decade.

(iii) Refinement and development of the GOOS plan, expansion of the scope of GOOS as required by new priorities

82. This refinement will largely depend on the results of the large-scale, long-term oceanographic experiments now underway or planned, as well as the development of new ocean monitoring technologies. This action is also a recognition of the fact that GOOS must be a dynamic, self-adjusting system, responsive to new requirements, new understanding of ocean processes and the development of new technologies.

(iv) Enhanced support for developing countries, to foster participation in the implementation of GOOS among these countries and in the interpretation and application of data obtained, in particular through the WMO Voluntary Cooperation Programme and the IOC Training, Education, and Mutual Assistance (TEMA) Programme

83. GOOS can be successfully implemented only through the involvement and contribution of all nations with an interest in the oceans. Appropriate mechanisms for facilitating such involvement are the assistance programmes of the IOC and the WMO. Through these programmes, support can be directed specifically to implementation of GOOS priorities. At the same time, assistance will be needed by many countries to enable them to take full advantage of the enhanced data and products to be generated by GOOS. Such needs call for greatly expanded TEMA activities in marine science by IOC and also in cooperation with other United Nations agencies and organizations.

(v) Implementation and evaluation of a series of global coastal monitoring pilot projects

84. The proposed IOC-UNEP-WMO global coastal and near-shore monitoring programme is an important initiative for coastal states, aiming toward the provision of a long-term monitoring system and data base relevant to studies of climate-induced changes in the coastal and near-shore zone. However, it is also ambitious and it is important to test both feasibility and applications of the data during a pilot phase and to carefully evaluate the results of this phase before making long-term commitments. The projects of the pilot phase should be implemented through existing mechanisms of the sponsoring organizations.

(vi) Continuation by IOC, WMO and UNEP of planning activities for the establishment and satisfactory maintenance of GOOS

85. Under the leadership of IOC, promotion of GOOS is to continue with an emphasis on effective intergovernmental coordination of relevant plans. Actions include the development of an operational GOOS Support Staff within the IOC Secretariat to promote and co-ordinate plans and activities and establishment of appropriate intergovernmental mechanisms essential for effective liaison with relevant activities including scientific programmes and the Global Climate Observing System initiative.

V. CONCLUSIONS

86. During the decade of the 1990s we have a significant opportunity and an urgent need to increase our observations of the marine environment. Advances in space-based and in situ observing technologies make it possible to determine on local, regional, and global scales changes in the oceanic system. Computer technologies and global models of the ocean and atmosphere are approaching the point where extensive data sets can be used to predict future states of the Earth system.

87. Social and economic developments over many millennia have been based on extensive use of the marine environment, and current demographic patterns show increasingly intense utilization of the coastal zone by mankind. Future development will be sustainable only if it is based on a solid understanding and predictability of marine environmental conditions.

VI. LIST OF REFERENCE DOCUMENTATION

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Annex 1

Resolution XVI-16

PREPARATION FOR THE 1992 UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT

The Intergovernmental Oceanographic Commission,

Recalling Resolution EC-XXIII.3 on the IOC contribution to the 1992 United Nations Conference on Environment and Development,

Noting with satisfaction the active participation of IOC representatives in the work of the Preparatory Committee for UNCED and in the preparation of documentation for UNCED,

Considering the great importance attached to the development of observations and monitoring of the oceans, shelf seas, the coastal zone, enclosed and semi-enclosed seas, for climate and global change and the state of the health of the ocean and the importance of addressing all these components at UNCED,

Noting also Recommendation OPC-IV.3 of the Fourth Session of the IOC Committee on Ocean Processes and Climate on the preparation of a draft declaration for adoption at the 1992 UNCED that would encourage countries to contribute to the development and implementation of the comprehensive Global Ocean Observing System,

Emphasizes the importance of using UNCED and its preparatory committees in increasing awareness of the role of the ocean in the global environment and of the importance of ocean resources, in order to encourage national commitments to a Global Ocean-Observing System;

Approves the attached Statement and Declaration for UNCED and **requests** the Chairman of IOC to bring this Statement and Declaration to the attention of the 1992 UNCED for its adoption;

Urges Member States to bring this Statement and Declaration to the attention of their national representatives to the 1992 UNCED;

Encourages the continued development, in co-operation with WMO and UNEP, of such observations and monitoring, also seen in the context of the development of the Earth Watch System;

Instructs the Secretary to continue active IOC involvement in the work of the UNCED Preparatory Committee.

Annex to Resolution XVI-16

Statement for UNCED by the Sixteenth Assembly of the Intergovernmental Oceanographic Commission

Paris, France, 7-22 March 1991

The Sixteenth Assembly of the Intergovernmental Oceanographic Commission of UNESCO, deeply concerned with the need to improve understanding and prediction of the physical state and health of the ocean and its role in environmental change and economic development, requests the United Nations Conference on Environment and Development to consider and adopt the declaration in the Conclusion to the present Appendix.

I. Introduction

1. The oceans cover nearly three-fourths of the earth's surface and are essential to the health of life on this planet. A substantial and increasing proportion of the global population live within the influence of the coastal zone. Our understanding of ocean processes is developing rapidly through the implementation of several major research programmes. Yet we need significantly expanded data on the marine environment to understand the physical and chemical processes involved, the interaction with the atmosphere, the complex coastal, benthic and deep-ocean ecology or the anthropogenic impacts that are taking place.

2. The ocean plays a key role in determining the earth's climate. The ability to understand and predict weather and climate beyond a few weeks requires that ocean behaviour be taken into account. It may soon be possible to describe and predict many aspects of ocean behaviour with enough accuracy to improve significantly climate, weather and fishery forecasts. This achievement can be realized only if appropriate observations of the oceans are made systematically and the data and analyses disseminated promptly.

3. Global changes affect coastal areas. In addition to natural climate change and variability, present evidence of anthropogenic environmental change in the ocean and the atmosphere, involving a number of physical, chemical and biological processes, portends significant socio-economic impacts. Monitoring and predicting such changes is a prerequisite to establishing adaptive policies. Mankind's timely and effective response to changes will largely depend on the quality of information on the rate and magnitude of change at regional and global scales.

II. Intergovernmental Decisions

4. In order to address these needs, a number of intergovernmental organizations have adopted policies to respond to these challenges.

5. United Nations General Assembly Resolution 44th Session, Second Committee, 22 December 1989, states that "Protection of the oceans and all kinds of seas, including enclosed and semi-enclosed seas, and of coastal areas and the protection, rational use and development of their living resources"

and "Protection of the atmosphere by combatting climate change, depletion of the ozone layer and transboundary air pollution" is of major concern in maintaining the quality of the global environment (A/C.2/44/L.86).

6. The Second World Climate Conference (29 October-7 November 1990) adopted conclusions and recommendations which indicate an urgent need to create a Global Climate Observing System (GCOS). The Conference Statement noted the importance of developing a Global Ocean Observing System of physical, chemical and biological measurements as one basis for a GCOS, and cited the importance of both space-based and surface-based observing components. The Conference also indicated that a GCOS should meet the needs for climate system monitoring, climate change detection and response monitoring, especially in terrestrial ecosystems; data for application to national economic development; and research towards improved understanding, modelling and prediction of the climate system.

7. The UNESCO Third Medium Term Plan (1990-1995), which the UNESCO General Conference adopted at its 25th Session, (November, 1989), includes a commitment to substantially accelerate existing ocean observing activities for research and operational uses.

8. Many millions of people living in low-lying coastal, deltaic and island environments are threatened by sea level rise and storm surges. Small island states are particularly vulnerable. The Malé Declaration on Global Warming and Sea-Level Rise, adopted at the Small States Conference on Sea-Level Rise held in Malé, Republic of Maldives, (14-18 November 1989), proposes the establishment of a climate and sea- level monitoring network.

III. Action taken

9. In response to these decisions, the Intergovernmental Oceanographic Commission has decided to pursue a major intergovernmental initiative to develop a Global Ocean-Observing System required for monitoring and predicting environmental changes to meet global, regional and national interests. This system, to be co-ordinated by IOC, will provide for regular observations of major physical, chemical and biological properties of the World Ocean, including the coastal zone and enclosed and semi-enclosed seas. It will address such issues as global climate predictions and sea- level rise, as well as the coastal marine environment problems of Member States. Initial implementation will use existing intergovernmental programmes and will be continually updated and improved with the addition of new elements in response to the results of ocean research programmes and development and transfer of new technology.

10. Established operational ocean observing systems can provide the basis for the development of a comprehensive, integrated system. This system needs to be improved and augmented by ocean remote sensing, an expanded sea-level network, wide use of automated observational systems and the incorporation of new technology. Development of systems for routine biological and chemical measurements is required. The international system for collection and exchange of data and data products should be further improved. Standards need to be established.

11. Substantial training, education and mutual assistance efforts must be undertaken to establish partnerships with developing countries. Training must be provided, and exchange of technology and products should be encouraged. The full implementation of GOOS will result in a significant increase in observing elements and therefore it should be recognized that a significant assistance programme is required.

12. Close and permanent interaction is required with the international scientific community, including the International Council of Scientific Unions. Specifically, large-scale research programmes such as the Study of Tropical Ocean and Global Atmosphere, the World Ocean Circulation Experiment and the Joint Global Ocean Flux Study will ensure the sound scientific basis for GOOS design and the application of GOOS data for analysis and prediction of the state of the marine environment.

13. Climate-related components of the Global Ocean Observing System will be developed jointly with the World Meteorological Organization as the ocean component of the Global Climate-Observing System; coastal and near-shore monitoring components related to climate change will be developed jointly with the United Nations Environment Programme and the World Meteorological Organization.

14. A Global Ocean-Observing System requires continuous and systematic data gathering, exchange, processing, and distribution of products, with the addition of operational funding and resources to the scientific base. Existing activities tend to be driven by research programmes rather than operational needs, and include a diverse array of platforms, agencies and programmes. Existing monitoring and data exchange systems have, however, substantial gaps in spatial and temporal coverage that would be needed to meet climate-scale and environmental monitoring needs.

IV. Conclusion

15. Therefore, the Member States of the Intergovernmental Oceanographic Commission recommend that the Conference adopt the following statement:

V. Declaration on a Global Ocean-Observing System

> Recognizing the key role of the oceans in determining the earth's climate, and recognizing the present evidence of anthropogenic environmental changes in the oceans, the Conference assigns a high priority to planning, implementing and maintaining a Global Ocean Observing System for the collection, analysis and distribution of data and information from the oceans and all kinds of seas, including enclosed and semi-enclosed seas, and from coastal areas. This system should be based on the principle of free and open exchange of data and the resulting information and benefits. The Conference requests the Intergovernmental Oceanographic Commission to continue the development of this system, in cooperation with other international organizations. The Conference urges countries to support this system through their national facilities and services based on the principle that each country participate, according to its means, so that all countries may benefit.

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
(of UNESCO
Member States of the Commission (117)
(as of 11 March 1991)

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URUGUAY
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VIETNAM
YUGOSLAVIA

In accordance with its Statutes the Intergovernmental Oceanographic Commission is a functionally autonomous body within the United Nations Educational, Scientific and Cultural Organization (UNESCO). The purpose of the Commission is to promote marine scientific investigations and related ocean services, with a view to learning more about the nature and resources of the oceans through the concerted actions of its Members. One function is to promote, plan and co-ordinate observing and monitoring systems on the properties and quality of the marine environment, as well as the preparation and dissemination of processed oceanographic data and information, and of assessment studies.

VI. DESCRIPTION OF EXISTING SYSTEMS

a. **World Weather Watch (WWW)** - the world-wide, co-ordinated, developing system of meteorological facilities and services provided by Members for the purpose of insuring that all Members obtain the meteorological information they reguire both for operational work and for research. The essential elements of the WWW are: The Global Observing System - the co-ordinated system of methods, techniques and facilities for making observation on a world-wide scale within the framework of the WWW, the Global Data Processin System - the co-ordinated global system of meteorological centres and arrangements for the processing, storage and retrieval of meteorological information within the framework of the WWW, and the Global Telecommunications System - the co-ordinated global system of telecomunications facilities and arragements for the rapid collection, exchange and distribution of observations and processed information within the framework of the WWW. Although WWW surface coverage is extensive, large voids exist over ocean areas, especially in the southern hemisphere. The WWW includes about 7000 ships recruited by 49 countries who participate in a Voluntary Observing Ships scheme to provide marine meteorological information. Polar-orbiting satellites are operated by four countries with plans underway for additional satellite series; geostationary satellites are also operated by four countries. Priority needs to be given to an assessment of present and foreseeable ocean remote sensing capabilities. Years of advance planning are needed to design sensor and platform configurations, and promising research systems need to be evaluated for potential use as operational systems.

b. **Integrated Global Ocean Services System (IGOSS)** - the international operational system for the global collection and exchange of oceanic data and the timely preparation and dissemination of oceanic products and services. IGOSS is planned, developed and co- ordinated jointly by the IOC and the WMO, and consists of national facilities and services provided by the participating Member States themselves, which share data for mutual benefit. The IGOSS structure is similar to that of the WWW, i.e., the IGOSS Observing System, the IGOSS Data Processing and Services System and the IGOSS Telecommunications Arrangements (chiefly based on the WWW GTS). About one-third of the established goals for 1989-1995 have been achieved. Substantial additional national commitments are needed to provide adequate coverage, particularly in the Indian and Southern Oceans - data-sparse areas.

c. **Global Sea Level Observing System (GLOSS)** - the IOC programme for the provision of standardized sea level data from a global network of stations. Presently about 200 of the 306 proposed stations are operational, with the support of 79 countries. Establishment and maintenance of stations in the Antarctic and Arctic, as well as in Africa and on remote islands, requires substantial effort.

d. **Drifting Buoy Activities** - managed by the IOC-WMO Drifting Buoy Co-operation Panel. The Panel was established to insure the optimum use of drifting buoy deployments and to maximize the amount of buoy data available to the relevant IOC and WMO programmes. Approximately 600 buoys are now operated by 11 countries, with 35 per cent transmitting data in via the GTS. That proportion is increasing.

e. **International Oceanographic Data and Information Exchange (IODE)** - the IOC programme for international exchange of ocean data through a network on national oceanographic data centres, designated national agencies, responsible national oceanographic data centres, and world centres. A total of 42 countries now have national data centres or designated national agencies. Established in 1960 to facilitate the exchange of oceanographic data and information among Member States of the IOC, the IODE system provides standard forms for coding and reporting data, encourages the preparation of data catalogues and assists in developing national oceanographic data centres. The system is based on the principle that national institutions, international programmes, and individual scientists contribute data voluntarily to the IODE data centres for the benefit of all. System users can then obtain free of charge or at a low price data, data products or data inventory information. A Marine Environmental Data and Information Referral System (MEDI) provides a multi-disciplinary source guide to the availability and creation of marine environmental data. The IODE Network includes: National Oceanographic Data Centres (NODCs) - NODCs provide the contact with the oceanographic programmes of a Member State. In addition to responsibilities for data collection, processing, quality control, archiving and dissemination nationally, NODCs are responsible for international exchange. Responsible National Oceanographic Data Centres (RNODCs) - RNODCs assist World Data Centres with particular requirements for data provision or retrieval or with a particular type of data or specific region. There are 12 RNODCs. World Data Centres for Oceanography (WDCs) - WDCs for Oceanography, established within the ICSU WDC system, are also recognized as IODE centres. These WDCs receive oceanographic data and inventories from NODCs, RNODCs, marine science organizations and individual scientists, freely exchange data, publications and inventories among one another, and provide, upon request, copies of data, inventories and publications. WDCs are located in Moscow, Washington and Tianjin, PRC. As of 1988 the WDCs held data for more than 2,250,000 observations, including data from 960,000 oceanographic stations, 505,000 bathythermographs, 135,000 biological observations and 660,000 current measurements.

f. **World Climate Programme** - promotes, under the auspices of WMO, internationally co-ordinated research and monitoring of climate variations or changes, including a Climate Change Detection Project initiated in 1989. It also promotes the use of climate information to assist economic and social planning and development.

g. **Global Environmental Monitoring System (GEMS)** - a UNEP programme to promote the coordination and collection of environmental data and as the heart of the United Nations system-wide "Earthwatch". Earthwatch, as defined by the 4th Session of the UNEP Governing Council, is a "dynamic process of integrated environmental assessments by which relevant environmental issues are identified and necessary data are gathered and evaluated to provide a basis of information and understanding for effective environmental management". The four main programme areas of GEMS are climate-related monitoring, monitoring of renewable resources, monitoring of environmental pollution, and collection of environmental data. A Georeferenced Information Databank (GRID) is a component of GEMS and is used for local and regional development and planning purposes.

h. **International Environmental Information System (INFOTERRA)** - a UNEP programme designed as a mechanism for nations to gain access to environmental information. It is a referral service for scientific and technological information.

i. **Global Investigation of Pollution in the Marine Environment (GIPME)** - IOC programme implemented in close co-operation with UNEP, IAEA, IMO and ICES. The Global Investigation of Pollution in the Marine Environment (GIPME) is conceptually bi-modal; there are the regional activities being implemented under the umbrella of Marine Pollution Monitoring System (MARPOLMON) and the really global elements such as the development of methodologies, intercalibration exercises to ensure inter-comparability of results from various laboratories and regions, etc.

The GIPME Action Plan is being executed through three specialized groups namely, the Group of Experts on Methods, Standards and Intercalibrations (GEMSI), the Group of Experts on Effects of Pollutants (GEEP) and the Group of Experts on Standards and Reference Materials (GESREM).